ECONOMICS OF SOIL AND WATER CONSERVATION: EFFECTS OF PRACTICES FOLLOWED ON FARMS IN SELECTED ILLINOIS AREAS

BY

ELMER LOUIS SAUER

B.S., University of Illinois, 1931
M.S., University of Illinois, 1934

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL ECONOMICS
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ECONOMICS OF SOIL AND WATER CONSERVATION: EFFECTS OF PRACTICES FOLLOWED ON FARMS IN SELECTED ILLINOIS AREAS

The intent of this study was to measure the effect of soil and water conservation on crop and livestock production and on farm incomes in selected areas of Illinois. Data were obtained concerning production, conservation and other operating costs, and incomes on sample farms of similar land use capabilities but with differences in the amount of soil and water conservation practices.

Conservation as used in this study refers to the intelligent use of soil and water resources including the use of land in accordance with its capabilities and the use of practices to lessen or prevent soil and water runoff and erosion and to maintain or improve soil fertility.

Source of data. The data used were obtained from farmers by the survey method, from farm account summary sheets in the files of the Department of Agricultural Economics, College of Agriculture, University of Illinois, and from field records and soil conservation surveys of the Soil Conservation Service, U. S. Department of Agriculture.

Areas studied. Six sample areas were used: Jefferson County; Madison and St. Clair counties; McLean County; Stephenson, JoDaviess and Winnebago counties; Northeastern Illinois slowly permeable till soils; and Central Illinois cash grain area. Farms with conservation plans at least three years old and with a large percentage of application of conservation practices were "paired" with physically comparable farms not having conservation plans.

Conservation and management scores. A soil conservation score was computed for each farm based on the degree to

which conservation measures needed had been applied to the farm. The farms with conservation plans were labeled, "Farms with High Conservation Scores," and those without conservation plans, "Farms with Low Conservation Scores." A management score, based on an evaluation of the operator's abilities in livestock management, adequacy of power and equipment, timeliness of field operations, and seed selection and treatment, was computed for each farm.

Costs and Benefits of Conservation

The costs of and benefits from conservation varied from area to area, reflecting differences in soil resources, type of farming, and local variations in weather.

Conservation needs and conservation expense. The farms with high conservation scores spent more per acre for conservation than the low score farms. A higher proportion of the gross income was required for conservation in the poorer land areas (Table 1). The lower level of soil fertility and, consequently, greater needs for limestone, phosphate and fertilizer caused higher conservation costs in Jefferson County.

Table 1.—Conservation Needs, Conservation Expense Per Acre and Percent Conservation Expense is of Gross Income, Farms with High and Low Conservation Scores, by Areas.

Item and Area	Farms With High Scores Col. (1)	Farms With Low Scores Col. (2)	Difference Col. 1 Minus Col. 2
Total Conservation Needs Per Acre:			
Jefferson	$22.63	$20.22	$2.41
Madison-St. Clair	17.27	15.78	1.49
McLean	20.98	20.32	.66
Stephenson-JoDaviess-Winnebago	15.85	14.50	1.35
Conservation Expense, 1945:			
Jefferson	2.10	1.30	.80
Madison-St. Clair	2.00	.96	1.04
McLean	2.33	1.86	.47
Stephenson-JoDaviess-Winnebago	1.45	1.11	.34

(Table 1 Continued on Page 3)

Item and Area	Farms With High Scores Col. (1)	Farms With Low Scores Col. (2)	Difference Col. 1 Minus Col. 2
Northeastern Illinois:			
Clarence-Rowe Soils	1.70	1.08	.62
Clarence-Swygert-Elliott Mixed Soils	2.51	2.03	.48
Cash Grain[a]	3.29	1.99	1.30
Conservation Expense, Percent of Gross Income, 1945:			
Jefferson	10.1	10.1	0
Madison-St. Clair	5.2	3.3	1.9
McLean	4.3	3.6	.7
Stephenson-JoDaviess-Winnebago	3.1	2.7	.4
Northeastern Illinois:			
Clarence-Rowe Soils	4.9	4.5	.4
Clarence-Swygert-Elliott Mixed Soils	6.0	7.3	−1.3
Cash Grain[a]	5.9	4.6	1.3

[a]Five-year average, 1941-45. Includes expense for all capital improvements for land and buildings.

Crop yields. The crop yield index was significantly higher on the farms with high scores in each of the six areas studied (Table 2). The soil fertility program, improved land use program, and use of practices such as contouring, strip cropping, terracing, tile and surface drainage, etc., accounted for from nine to 21 points increase in crop yield index for the six areas studied.

TABLE 2.—Crop Yields by Areas, Farms with High and Low Conservation Scores, 1945.

Item and Area	Farms With High Scores Col. (1)	Farms With Low Scores Col. (2)	Difference Col. 1 Minus Col. 2
Crop Yield Index[a]			
Jefferson	110	89	21
Madison-St. Clair	107	94	13
McLean	106	94	12
Stephenson-JoDaviess-Winnebago	105	95	10
Northeastern Illinois:			
Clarence-Rowe Soils	110	91	19
Clarence-Swygert-Elliott Mixed Soils	108	92	16
Cash Grain	105	96	9

[a]Average yields of all crops for all farms in each area equals 100.

Livestock production. The farms with high scores produced more meat and milk per acre than the farms with low scores (Table 3).

TABLE 3.—Units of Livestock Production Per Acre by Areas, Farms with High and Low Conservation Scores, 1945[a].

Item and Area[b]	Farms With High Scores Col. (1)	Farms With Low Scores Col. (2)	Difference Col. 1 Minus Col. 2
Pounds Meat Plus 10 Pounds Milk Per Acre:			
Jefferson	103	74	29
Madison-St. Clair	174	124	50
McLean	272	216	56
Stephenson-JoDaviess-Winnebago	280	247	33
Northeastern Illinois:			
Clarence-Rowe Soils	112	59	53
Clarence-Swygert-Elliott Mixed Soils	153	58	95

[a]One pound of meat or 10 pounds of milk is used as a unit of livestock production.

[b]These data were not available for the cash grain area.

Net income. The farms with high conservation scores had significantly higher incomes than the farms with low conservation scores (Table 4).

TABLE 4.—Net Income Per Acre by Areas, Farms with High and Low Conservation Scores, 1945.

Area	Farms With High Scores Col. (1)	Farms With Low Scores Col. (2)	Difference Col. 1 Minus Col. 2
Jefferson[a]	$20.80	$12.97	$7.83
Madison-St. Clair	14.60	6.29	8.31
McLean	27.51	22.64	4.87
Stephenson-JoDaviess-Winneabgo	21.23	13.86	7.37
Northeastern Illinois:			
Clarence-Rowe Soils	14.39	6.39	8.00
Clarence-Swygert-Elliott Mixed Soils	18.92	10.60	8.32
Cash Grain	32.19	25.54	6.65

[a]Gross income for Jefferson County; net income for all other areas.

Jefferson County. Conservation needs in this mixed

farming area include fertility improvement, land use adjustment, rotations using deep-rooted legumes, erosion control and drainage. The productivity level and earnings of farms are very low unless a soil conservation and fertility improvement program is applied. Conservation plans made it possible to use the land more productively. The farms with higher conservation scores had in 1945 larger acreages in corn and soybeans, small grains, and legume hay and rotation pasture, and less cropland idle. Low earnings and the consequent lack of capital are major factors limiting conservation in this area.

Madison-St. Clair counties. Major conservation problems in this wheat, dairy and poultry farming area are fertility improvement, erosion control and drainage. Farm account records were used and the level of management was above the average for all farms in this area. The farms with high conservation scores had a higher proportion of their land in hay and pasture (particularly legumes) and a lower proportion in small grains, intertilled crops and idle. Wet weather in 1945 operated to widen differences in earnings. The high conservation farms, with more and better quality pasture, had higher livestock production and were not affected so adversely by the wet weather.

McLean County. Sheet and gully erosion and drainage problems, resulting in large part from continuous cropping with soil depleting and intertilled crops which have depleted organic matter and available soil fertility, constitute a major conservation problem in this area. The farms used represent better than average management and application of conservation practices. The high score farms had a slightly higher proportion of their cropland in deep-rooted legumes and a smaller proportion in intertilled crops. The major difference in conservation on the two groups of farms was in the application of conservation practices such as contouring, terraces, grass waterways, surface drainage, use of rotations with deep-rooted legumes and other practices which

involve little, if any, extra cash cost. The high conservation score farms in McLean County were using their land more intensively than normal due to the wartime demand for corn and soybeans, therefore, the differences between the two groups are not as pronounced as for high and low conservation groups in the other areas.

Stephenson, JoDaviess, and Winnebago Counties. Erosion control and fertility improvement are major conservation problems in this area. The farms with high scores had a higher proportion of their land in hay and pasture, particularly legumes, and a lower proportion in small grains and idle. Increases from contouring, strip cropping, terracing, grass waterways, surface drainage, and pasture improvement demonstrate the increases in production and income that conservation and good management make possible.

Northeastern Illinois Slowly Permeable Till Area. The slowly permeable till soils have a heavy plastic subsoil which impedes the normal movement of water, causing serious erosion on the sloping areas and poor drainage on the level areas. In addition, these soils are generally acid and low in phosphate. In general, the area has been intensively cropped and both organic matter and fertility are low. The Clarence-Rowe soils in this group are more nearly impermeable and erosion and drainage problems are generally more serious for those soils than for the mixed Clarence-Swygert-Elliott soils. In both the Clarence-Rowe and the mixed Clarence-Swygert-Elliott groups the farms with high conservation scores had significantly higher returns. These higher earning farms had a higher proportion of their land in deep-rooted legumes and a smaller proportion of their land in soybeans. They had applied more phosphate and limestone, produced more livestock and applied more manure. The farms with high conservation scores represent better than average management, while the farms with low scores probably represent close to average management for this area.

Cash Grain Area of Central Illinois. Comparisons here were made between "matched" farms grouped according to proportion of land in legumes in nine central Illinois counties. Land use adjustment is the major problem of conservation in the area. On many farms corn and soybeans account for as much as 75 percent of the tillable land, small grains another 10 to 20 percent, leaving only a small proportion in deep-rooted legumes. The study centered around a comparison between farms having less than 10 percent of their tillable land in legumes and physically comparable farms having 20 percent or more of their tillable land in legumes. Data were based on the five-year average, 1941-45. The farms with the most legumes had a higher percent of their tillable land in corn but a smaller percent in soybeans. They had 48 precent of their tillable land in these two crops, compared to 65 percent for the farms having the least legumes. Legume acreage averaged 23.6 percent for the former group and 7.3 percent for the latter group.

Long-Time Benefits from Conservation. Yields and income are increasing on the farms with high conservation scores relative to the farms with low scores, as observed in three areas in which long-time farm records were available on identical farms (Table 5).

TABLE 5.—Yields and Income on Identical Farms for Two Periods, by Areas, Farms with High and Low Conservation Scores[a].

Area and Years	Crop Yield Index		Net Income Per Acre	
	Farms With High Scores	Farms With Low Scores	Farms With High Scores	Farms With Low Scores
Madison-St. Clair				
1939	100	100	$ 9.87	$ 9.84
1945	107	94	14.60	6.29
Stephenson-JoDaviess-Winnebago				
1940	98	102	12.46	12.91
1945	105	95	21.23	13.86
McLean				
1936	97	103	5.78	6.54
1945	106	94	27.51	22.64

[a]Conservation scores as computed for the year 1945.

Significance of Comparisons Between Conservation and Management

Cross tabulation analyses indicated the relative influence of conservation scores and of management scores as used to be as shown in Table 6. Limits on the significance of these are discussed in the following paragraph.

Table 6.—Proportion of the Difference in Income and Yields Between High and Low Conservation Farms that May Be Attributed to Conservation and to Management Other Than Conservation.

Area	Yields		Income	
	Percent of Difference Attributed to:		Percent of Difference Attributed to:	
	Conservation	Management	Conservation	Management
Jefferson	60	40	76	24
Madison-St. Clair	87	13	73	27
McLean	62	38	64	36
Stephenson-JoDaviess-Winnebago	72	28	70	30

The validity of the conclusions to be drawn regarding the relative effects of conservation and management depends in part upon how well the two scores actually measured conservation and management other than conservation. It is the writer's opinion that the conservation score was adequate and satisfactory. However, the writer recognizes that the management score may have been inadequate. An analysis of farm account data for one of these areas indicates that if four management factors (1) corn yield, (2) horse and machinery efficiency index, (3) labor efficiency index, and (4) livestock efficiency index had been used as a measure of management, 55 percent of the differences in earnings per acre would have been accounted for by conservation and 45 percent by these management factors instead of 70 percent by conservation and 30 percent by management as shown in this study (Table 6). It is probable that the importance of conservation might have been similarly reduced in other areas if an objective management score had been

used.

In areas in which data were based on surveys, it was not possible to obtain data which permitted objective evaluation of management. Although management data could have been derived from records in other areas, the same management score based on opinions was used in order to have uniformity throughout the study.

Another qualification necessary in interpreting the tables reporting the relative effects of conservation and management is that in grouping the farms for these tables, they were shifted without regard to comparability of soil resources and so the identity of land use capability maintained in the direct comparisons of high and low conservation farms was lost. Some of the differences found may be explained by this fact.

Because of small samples the data were grouped in these tables into four groups with equal numbers in each group, the dividing points being the high and low half for each factor. Because of intercorrelation between the two factors this method caused the differences between the groups to be affected by differences in averages for both factors rather than in only one. This may have reduced the validity of the conclusion as to the relative influence of conservation and management on earnings and yields.

Early in this study it was recognized that management other than conservation was an important factor affecting farm earnings. The writer believes that the management score could be improved and recommends that in subsequent studies a technique for measuring management be formulated from the data obtained rather than drawn subjectively from opinions of informed observers. However, the evidence is sufficiently strong to support unquestionably the conclusion that conservation is a most important factor influencing the level of farm earnings.

CONCLUSIONS

Farms with high conservation scores tended to follow a complete conservation plan, including (1) testing and treating the soil, (2) using the land according to its capabilities, (3) using rotations with ample acreages of deep-rooted legumes, and (4) using proper water disposal practices, such as grass waterways, contouring, strip-cropping, terracing, tile and open-ditch drainage where needed.

Conservation farming increased crop yields by 9 to 21 percent in the six areas studied. Both higher yields and the larger acreages of better pastures caused the high conservation farms to produce more total digestible nutrients, and this resulted in higher livestock production on such farms than on the low conservation farms. The higher production on the high conservation farms is reflected in higher incomes. Differences in net farm incomes per acre for high and low score farms varied from $4.87 in McLean County to $8.32 in the mixed soils area of Northeastern Illinois. In addition to increasing current income conservation prevents soil erosion and the loss of capital resources, and thus leaves the farm more productive.

At 1945 price levels, a high conservation farm of 160 acres would have earned above a low conservation farm:

Jefferson County	$1,254
Madison-St. Clair Counties	1,330
McLean County	779
Stephenson-JoDaviess-Winnebago Counties	1,179
Northeastern Illinois: Clarence-Rowe Soils	1,280
Mixed Clarence-Swygert-Elliott Soils	1,331
Cash Grain Area of Central Illinois	1,064

The increased incomes on the high conservation score farms would have been significant, even at the 1935-1939 level of farm prices. At 1935-1939 prices the earnings of an 160 acre high conservation farm would have exceeded earnings on a low conservation farm by:

Jefferson County	$732
Madison-St. Clair Counties	778
McLean County	456
Stephenson-JoDaviess-Winnebago Counties	689

Northeastern Illinois: Clarence-Rowe Soils	749
Mixed Clarence-Swygert-Elliott Soils	779
Cash Grain Area of Central Illinois	622

Annual conservation costs in 1945 on an 160 acre high conservation farm would have exceeded costs on a low conservation farm by:

Jefferson County	$128
Madison-St. Clair Counties	167
McLean County	76
Stephenson-JoDaviess-Winnebago Counties	55
Northeastern Illinois: Clarence-Rowe Soils	100
Mixed Clarence-Swygert-Elliott Soils	77
Cash Grain Area of Central Illinois	160

Differences between earnings of conservation and non-conservation farming as measured by the differences between farms with high conservation scores and farms with low conservation scores are gradually becoming wider. The farms with high conservation scores are maintaining or increasing their production and income relative to the farms with low conservation scores, upon which yields, production and income are diminishing.

The costs of a complete conservation program are high, varying by areas from $15.85 to $22.63 per acre. In 1945, farms with high conservation spent on the average in different areas from 3.1 to 10.1 percent of their gross income for conservation. A higher proportion of the gross income was required for conservation in the poorer land areas.

Increased earnings were not immediate, and considerable time and money were expended before such positive results were achieved. The high conservation score farms used in these comparisons have had plans in operation from one to eight years. Some of the benefits of conservation, such as yield increases from contouring, show up the first year, but increases in yields from applications of limestone generally do not show up until the rotation has gone through a complete cycle and a crop of clover or other legumes has been plowed down.

Farmers are interested vitally in the economic returns

from their farm businesses. Before they make changes, they ask "Will it pay?" The longtime benefits of conservation are positive. Comparison of farms having complete conservation plans with neighboring, otherwise comparable farms show that the conservation farms had more land in legumes and grasses, had higher crop yields, produced more and better quality hay and pasture, fed more livestock, had higher livestock production and returns, and secured larger net farm incomes. Sound conservation programs provide income for the needs of today and a heritage for the needs of tomorrow.

VITA

Elmer Louis Sauer was born near Sedalia, Missouri, on April 26, 1910. He was graduated from Winchester Community High School, Winchester, Illinois, in 1927. He received the degree of Bachelor of Science in Agriculture from the University of Illinois in 1931, and the degree of Master of Science in Agricultural Economics from the University of Illinois in 1934.

He was an assistant in Farm Management in the Department of Agricultural Economics, University of Illinois, from February, 1931, to November, 1936. Since November, 1936, he has been employed in the United States Department of Agriculture, Soil Conservation Service, Research Division, serving as Project Supervisor of research in the economics of soil and water conservation, a cooperative project between the Department of Agricultural Economics, University of Illinois and the United States Department of Agriculture.

From 1941 to 1946 he served as a member of the working committee for the Wartime Production Adjustment Studies of Illinois Agriculture and the Illinois Postwar Agricultural Adjustment Studies. He has been a member of the Technical Advisory Committee for the Agricultural Adjustment Administration conservation program in Illinois since its inception in 1943.

Published writings, as will be observed in the section, "Author's Writings on Soil Conservation Problems in Illinois," in the thesis bibliography, include 48 articles and reports (28 with co-authors) covering 558 pages on soil conservation problems in Illinois. This does not include the Production Adjustment Studies, including postwar planning reports, with other members of the Illinois Production Adjustment Committee, comprising 12 reports in 1942; two in 1943; three in 1944, and one in 1945.